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ABSTRACT

The challenge facing educators today is not just to use computers at school but to use computer education and "Informatics" (information plus automatics, placing computer education in the broader context of information and technology) to mediate improved social and learning relations in schools. In order to introduce computers into schools, a multidisciplinary and cooperative approach was used to develop a program using a working team of professionals in the areas of Informatics, cognitive psychology, education, visual programming (graphics), history, and a specialist in the production of didactic materials. The course was designed around three themes: (1) foundations of Informatics (history, function and uses of computers); (2) Informatics and Society (social impact and vocational and work market analysis); and (3) Interest Centers (workshops on many topics including art, games, literature, mathematics, pedagogical support, and library). This project is being applied to 20,000 students in 17 schools in Brazil. A package of teacher and student materials form the basis of a course to introduce Informatics to K-12 students. The project is evaluated according to its main characteristics: schedule, teachers, hardware, software, and didactic material. Feedback from the schools concerning the project has been favorable. (PVD)

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USING COMPUTERS IN K-12 SCHOOLS: A PROJECT PRESENTATION AND EVALUATION

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KEYWORDS

Educative Informatics, Learning & Teaching, Interaction, Interdisciplinary, Collaborative Apprenticeship.

ABSTRACT

We discuss the challenges facing educators to incorporate *informatics*[1] into the curriculum, with an interdisciplinary view in a collaborative way. By questioning the ways computers have been used in schools, we present our own way - ITECI's project, which is being applied, to 20,000 students, in 17 schools. We present a package of teacher and student materials, which form the basis of a course to introduce informatics for K-12 students. Then we outline the results of the projects' evaluation, considering its main characteristics.

INTRODUCTION

Developing a Pedagogy of Informatics involves collaboration in learning at a number of levels, i.e. the collaboration of educators as they work together on the conceptual and operational changes required if they are to teach both *about* the computer and *with* the computer; the collaboration of students as they learn together through activity-based and challenging learning opportunities; the collaboration of schools and communities as they come to terms with the role of education and schooling in the *information* society; and interdisciplinary collaboration in the development of curricula and educational programs.

[1] We have used the term *informatics* (information + automatics), because it places computer education in the broader context of information and technology.

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The idea is integrate two key objectives simultaneously:

- ***Informatics education***: to provide students with access to systemic knowledge about computers and information technology;
- ***Educative informatics***: to use computers and information technology as an educational resource for students and schools.

Both students and teachers need to master the machine, but if these skills alone form the basis of a program, there is a risk that students and teachers will behave like parrots (mere repeaters) without understanding what they are doing. On the other hand students who conceptually understand the structure and functioning of computers and software in both historic and contemporary contexts, will be able to infer, take risks and face new challenges creatively. This project therefore aimed to provide students (and teachers) with both the practical formation necessary for familiar and fluent use of computers and software, and the comprehension of how computers work and the part they play in our society.

COMPUTER AT SCHOOL - A TRADITIONAL USE

In recent years many institutions have studied informatics and its application in education, science and technology, and gained more experience in its use. Despite differences in methodology and context most of these studies focused on the fundamental need to manage the technology and to explore its resources in order to improve the educative, productive and scientific process of knowledge generation in the society.

Computers were introduced into educational programs for children with the "promise" or "belief" that through the computer students would learn more, read better, and work more creatively and cooperatively. However, the computer, reified in this way, has not corresponded to people's expectations of its potential in the learning and teaching situation.

A closer look at computer usage in schools shows that the main focus of computer education in schools has been on *computer skills*, e.g. word processing or information management, and little attention has been given to developing a pedagogy which integrates the teaching of computer skills with an understanding of informatics and its place in our society. Little or no attention has been given to what we have called a *Pedagogy of Informatics* which takes into consideration the learning and teaching processes, the organization of curriculum, and reflection on people/machine relationships in learning and in the wider community, as well as developing children's ability to use computers competently [Jurema et al., 1995].

Recent research in the US, Japan, Israel and some countries in the European community [Pelgrum & Plumb, 1991; Anderson, 1993; Lund & Wild, 1993; VISION TEST, 1990; Office of Technology Assessment, 1995] also shows this lack of focus on constructing a *Pedagogy of Informatics*.

THE PROJECT

The challenge facing educators today is not just to *use* computers at school, but to use computer education and informatics to mediate improved social and learning relations in schools. The introduction of informatics into the curriculum can assist schools to change from a traditional way of teaching and learning, to one that provides students with an ever more cooperative apprenticeship in the learning and teaching process, and prepares them to be lifelong learners, explorers and integrators of learning and experience. A key factor is assisting schools to respond to these challenges is the production of resource materials suitable for use with students at all stages of the educational process. However to be effective, these materials must express didactically the basic educational concepts that will facilitate the processes of working, teaching, communicating, and learning.

To introduce computers in schools we chose a multidisciplinary and cooperative approach to the development of the program by establishing a working team of professionals in the areas of informatics, cognitive psychology, education, visual programming (graphics), history, and a specialist in the production of didactic materials.

This working team produced an *Introductory Informatics Course for Children and Adolescents* [Jurema & Costa Lima, 1993a] which included both a methodology for teaching informatics to children and adolescents (K-12), and a series of teaching and learning programs across their age-range. It was designed to assist children and adolescents develop the abilities, understandings and values necessary to participate effectively in a society impregnated by computers and information technology. The K-12 focus also required that the multi-disciplinary aspect of school life be considered and promoted, and that informatics education be developed as an integrative element across the curriculum. The course was conceived with a deep concern of articulating computer related concepts to the subjects-matter taking part of the curriculum, and it was designed around three thematic nuclei:

- Foundations of Informatics (history, functioning and uses of the computer);
- Informatics and Society (social impact and vocational and work market analysis);
- Interest centers (workshops on many topics, including but not limited to, art, games, literature, mathematics, literature, pedagogical support, and library).

The project materials include mainly: textbooks (reference-book for students and teachers), activity challenges for students, manuals of methodological orientation and educational programs for teachers, and a support kit of educational software conceived and produced by the group. The software developed is simple and they were conceived to work on computers' concepts. For instance, a program to simulate and exemplify an algorithm - where the students learn the concepts through playing. Another program to work with associations and classifications of objects, and so on. These software require from the teacher to explore the ideas they represent and integrate them into the curriculum program. The teachers' manual presents activities, some alternative suggestions about ways to work with students within several subject matters. In short, they all work towards the integration of the program across the curriculum.

Collaborative processes are built into all activities of the project so that the cooperative and cognitive elements are intrinsically united. For example, when children work in teams to create databases, they generate findings, which have to be discussed, analyzed and communicated, in class, and require their active involvement in the reasoning process.

FOUNDATIONS FOR DEVELOPING A PROGRAM

To achieve a Pedagogy of Informatics, the multi-disciplinary team based the development of the program on a number of *foundational* premises, i.e.

- The interdisciplinary nature of informatics knowledge involves a range of subject areas and processes, including but not limited to mathematical, historical, linguistic, logical, conceptual, and graphic.
- Learners are active participants who in the course of their learning structure their experience and knowledge.
- The cooperative work of students and teachers creates a new cultural resource, which is greater than the knowledge and understanding that any of the individuals possessed before.
- Approaches, which are based on, the social and cognitive reality of students will develop learning experiences that are challenging and open-ended, enjoyable and playful, cooperative and socializing.
- Computers are a *means* not an *end*. In the educative process they do not replace people but assist them in reorganizing interactions, thus reorganizing the teaching and learning process (and the play).
- The content of knowledge and its daily application are intrinsically related. Therefore teaching and learning programs in addition to providing information about computers and information technology, must be functionally constructed (authentic learning), and also challenge learners to reflect on social impacts and implications (i.e. the relations of people with the machine and with one another).
- Informatics in schools is not an appendix to the educative process, but an integrated element of the school curriculum, which must enrich the teaching and learning situation.
- The *capacitation* of teachers is essential. An approach based on the pedagogy of informatics requires teachers to develop their own knowledge and understanding of informatics in our society, to rethink their roles and practices, and base their teaching on their students' curiosity and active involvement in their learning.

PROJECT EVALUATION

After some years of working with computers at school, throughout the IPA Project, ITECI hired an expert Consultant to conduct a project evaluation. The Consultant focused his attention into the Project structure, organization, contents, and its acceptation's from the schools and students point view. We have to say that during the project's first years, we've had some situations for whose we were not prepared. Our worries have been to keep

track of innovations - for instance Internet & Web, without loosing sight of working with concepts. Here we briefly present the results of that evaluation. We'll comment some decisions we made in way to adjust the project and improve its implementation.

1. Schedule: the schedule is rigid and students have no choices, all courses are required. Teachers, because of their low wages, usually teach in more than one school. In consequence, the definition of the courses' schedule, at school, has been a real puzzle for most of schools. It's not easy to establish an order prioritizing students' learning and, at the same time, satisfy teachers' interest within that school and theirs commitments outside school. Besides that, when schools have to consider one more party in their schedule definition, and that party doesn't come from school - it's an out side team, then that team in charge of computer will be the last one to be thought of. For that reason, it happened things like:

- Teachers with a lot of "windows" in their schedule - free time in between classes;
- Consecutive time class with a large difference level - 1st and 7th grades, for instance. That implies to have a teacher with a large and deep knowledge in computer science and some others school courses/areas, or to have one more teacher to serve the same school - some time a small one;
- Computer classes out of school schedule: either before regular classes start or after they have finished. That procedure unmotivate some students to come to computer classes, they began to see it as an extra effort without extra credit, almost like a punishment; and,
- As happened in one school, concentrate computer classes at the lunch and dinnertime, has proved to be a bad choice.

Since then, a couple of simple decisions have reduced a lot the possibility to have any kind of *dissatisfaction* with student, teacher and/or school:

- We haven't accepted a "windows" anymore in the teachers schedule;
- As an on-going project, we have convinced the schools that Informatics has to be seen as a regular school class. That's a needed temporary step, if they want to see Informatics integrated in their curriculum. To achieve that goal they have to work with us in the definition of their schedule.

Since we took these decisions, we have seen a much bigger student's interest in Informatics, and some few teachers start discussing and interacting with informatics teachers.

2. Teacher: at the beginning of the Project teachers were selected throughout their curriculum, an interview, and a writing paper about their motivation to participate in the project. In their day-by-day activities at school, we realized that the teachers that had a previous school practice did better than the others, *despite* of some times inferior academic curriculum. Some teacher-student relationship problem that appeared we observed they were usually related to lack of teacher's experience. Then we started asking for a previous class practice in the teacher selection, and we included an evaluation of a 90 days probation.

We observed that the teachers had some difficulties for their class planning and follow up, then we realized that most of them didn't have read the Project material - teacher and student books, for instance. We asked them to read it and, since then, we add that to their responsibilities as a teacher.

In a way to maintain a standard class planning, we grouped the teachers in teams of three, for each grade. We also decided to work with a "Class Notebook", where the teachers have to register what they have done in class, how they have done it, and any information they consider important. This class notebook has been useful for a course evaluation, and in the situation of teacher replacement necessity, if at any time a teacher eventually can not make his/her class.

Targeting a project development with students and the regular schoolteachers, we have oriented Informatics' teachers to work within specific areas.

3. Hardware: at present we didn't have problem to give the students access to the computers, they have their lab class and they can have some extra lab time when lab is not in use. Indeed, we have gotten some difficulties working with different computers' configurations at the same lab. We have correct that and now, in order to make easier to load and change software's, we are planning to wire the lab computers' in a local area network.

Each lab is always equipped with a new and up date computers. Even though, it occurs that they eventually *dysfunction*, and that may disturb a lot the lab class. For a while, the solution we, some times, have taken is to move the teachers computer into the lab. We don't like as much that solution because we are struggling to convince regular teachers to get familiar with computers, and if we take it out of their room, they can feel insecure about using them in their day by day activities.

4. Software: to work with to many different software's tend to be expensive, because of their price and maintenance effort that is needed. The informatics teachers we work with are not computer experts; they are, mainly, professionals in education. That is why most of them don't know how to solve some kind of bugs, and fix problems like lack o memory, computers' frozen, etc. The simple and frequent problems we want them know how to fix, for other less usual and much more sophisticated one ITECI provides a support for them.

5. Didactic Material: for some grades, the students' books were conceived, at the beginning, with exactly the same contents. Each grade's teacher has his/her own teachers' book, with the specific information about how the teacher should work with the students' book. Then, when the student book were the same, for different grades, its contents were worked in different and deeper level for the higher grades. Even though, the parents didn't understand that and we had to modify the student book, having now different activities, one for each grade.

From some evaluations we usually do with all the students, we got to know they enjoyed to work and to learn about computers. But the teenagers wanted to work with softwares that their parents and relatives were using, such as word processor, spreadsheet, and database. Since we did some modifications, working more with these kind of

software's, the students' satisfactions level grew higher. Furthermore, that made easier to integrate computers' in some others courses.

6. The Project: the evaluation from the schools perspective has been really good. Most the schools that choose this project to work with have the same methodological and background approach that characterizes the project. However, we have observed that they don't know exactly how to take advantage of Educative Informatics. We realized as well that the regular schoolteachers' are the key of the success in a long-term view.

In way to conquer the regular schoolteachers' attention and get close to them, the Educative Informatics' have been trying informal talks, always with some comments about what they are teaching the students. We also offered to them a 20 hours course where we present what Educative Informatics is, and how they should work with. That course replaced the previous 94 hours course we used to teach them. We realized some of them were getting scared with too much information that they were not able apply in their work. The course now is shorter and we give them a better support along their day-by-day activities at school.

CONCLUSION

A computer educational project produced by a working team at ITECI, based on this emerging Pedagogy of Informatics, has contributed to our knowledge about the use of computers and information technology in education. These materials - embedded in a methodology expressing a pedagogy of informatics - were first tested through intensive courses, and then successfully used for over six years. At present, that program is used at seventeen schools, involving approximately 20,000 students in the cities of Recife, Natal, and Fortaleza, Northeast of Brazil.

Our experience of practical cases and the follow up evaluations of ITECI's methodology and courses at schools settings have shown the importance of basing the uses of computer technologies at schools on a conceptual framework which encompasses multidisciplinary and collaborative approaches in its development and implementation. That led us to be skeptical about use of computers and special software techniques, if they are not connected with an appropriate pedagogy and methodology which guides on how to take advantage of them at the school setting.

As stated above (p.1) computer education in schools has not lived up to the high expectations with which it was introduced. In many cases as the speed with which the technology is developing simply means that teachers and schools get left further behind. This program has been successful in both, the capacitation of teachers and the development of a *Pedagogy of Informatics*. The project assists students to conceptually understand the structure and functioning of computers and software in both historic and contemporary contexts, and enable them to infer, take risks and face new challenges creatively. It is important that educators are given many opportunities to discuss and contribute to the emerging *Pedagogy of Informatics*, and to learn from successful programs such as this one.

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[1] We have used the term *Informatics* (Information + automatics), because it places computer education in the broader context of information and technology.

The idea is integrate two key objectives simultaneously:

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FOUNDATIONS FOR DEVELOPING A PROGRAM

To achieve a Pedagogy of Informatics, the multi-disciplinary team based the development of the program on a number of *foundational* premises, i.e.

- The interdisciplinary nature of informatics knowledge involves a range of subject areas and processes, including but not limited to mathematical, historical, linguistic, logical, conceptual, and graphic.
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After some years of working with computers at school, throughout the IPA Project, ITECI hired an expert Consultant to conduct a project evaluation. The Consultant focused his attention into the Project structure, organization, contents, and its acceptation's from the schools and students point view. We have to say that during the project's first years, we've had some situations for whose we were not prepared. Our worries have been to keep

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- Consecutive time class with a large difference level - 1st and 7th grades, for instance. That implies to have a teacher with a large and deep knowledge in computer science and some others school courses/areas, or to have one more teacher to serve the same school - some time a small one;
- Computer classes out of school schedule: either before regular classes start or after they have finished. That procedure unmotivate some students to come to computer classes, they began to see it as an extra effort without extra credit, almost like a punishment; and,
- As happened in one school, concentrate computer classes at the lunch and dinnertime, has proved to be a bad choice.

Since then, a couple of simple decisions have reduced a lot the possibility to have any kind of *dissatisfaction* with student, teacher and/or school:

- We haven't accepted a "windows" anymore in the teachers schedule;
- As an on-going project, we have convinced the schools that Informatics has to be seen as a regular school class. That's a needed temporary step, if they want to see Informatics integrated in their curriculum. To achieve that goal they have to work with us in the definition of their schedule.

Since we took these decisions, we have seen a much bigger student's interest in Informatics, and some few teachers start discussing and interacting with informatics teachers.

2. Teacher: at the beginning of the Project teachers were selected throughout their curriculum, an interview, and a writing paper about their motivation to participate in the project. In their day-by-day activities at school, we realized that the teachers that had a previous school practice did better than the others, *despite* of some times inferior academic curriculum. Some teacher-student relationship problem that appeared we observed they were usually related to lack of teacher's experience. Then we started asking for a previous class practice in the teacher selection, and we included an evaluation of a 90 days probation.

We observed that the teachers had some difficulties for their class planning and follow up, then we realized that most of them didn't have read the Project material - teacher and student books, for instance. We asked them to read it and, since then, we add that to their responsibilities as a teacher.

In a way to maintain a standard class planning, we grouped the teachers in teams of three, for each grade. We also decided to work with a "Class Notebook", where the teachers have to register what they have done in class, how they have done it, and any information they consider important. This class notebook has been useful for a course evaluation, and in the situation of teacher replacement necessity, if at any time a teacher eventually can not make his/her class.

Targeting a project development with students and the regular schoolteachers, we have oriented Informatics' teachers to work within specific areas.

3. Hardware: at present we didn't have problem to give the students access to the computers, they have their lab class and they can have some extra lab time when lab is not in use. Indeed, we have gotten some difficulties working with different computers' configurations at the same lab. We have correct that and now, in order to make easier to load and change software's, we are planning to wire the lab computers' in a local area network.

Each lab is always equipped with a new and up date computers. Even though, it occurs that they eventually *dysfunction*, and that may disturb a lot the lab class. For a while, the solution we, some times, have taken is to move the teachers computer into the lab. We don't like as much that solution because we are struggling to convince regular teachers to get familiar with computers, and if we take it out of their room, they can feel insecure about using them in their day by day activities.

4. Software: to work with to many different software's tend to be expensive, because of their price and maintenance effort that is needed. The informatics teachers we work with are not computer experts; they are, mainly, professionals in education. That is why most of them don't know how to solve some kind of bugs, and fix problems like lack o memory, computers' frozen, etc. The simple and frequent problems we want them know how to fix, for other less usual and much more sophisticated one ITEC1 provides a support for them.

5. Didactic Material: for some grades, the students' books were conceived, at the beginning, with exactly the same contents. Each grade's teacher has his/her own teachers' book, with the specific information about how the teacher should work with the students' book. Then, when the student book were the same, for different grades, its contents were worked in different and deeper level for the higher grades. Even though, the parents didn't understand that and we had to modify the student book, having now different activities, one for each grade.

From some evaluations we usually do with all the students, we got to know they enjoyed to work and to learn about computers. But the teenagers wanted to work with softwares that their parents and relatives were using, such as word processor, spreadsheet, and database. Since we did some modifications, working more with these kind of

software's, the students' satisfactions level grew higher. Furthermore, that made easier to integrate computers' in some others courses.

6. The Project: the evaluation from the schools perspective has been really good. Most the schools that choose this project to work with have the same methodological and background approach that characterizes the project. However, we have observed that they don't know exactly how to take advantage of Educative Informatics. We realized as well that the regular schoolteachers' are the key of the success in a long-term view.

In way to conquer the regular schoolteachers' attention and get close to them, the Educative Informatics' have been trying informal talks, always with some comments about what they are teaching the students. We also offered to them a 20 hours course where we present what Educative Informatics is, and how they should work with. That course replaced the previous 94 hours course we used to teach them. We realized some of them were getting scared with too much information that they were not able apply in their work. The course now is shorter and we give them a better support along their day-by-day activities at school.

CONCLUSION

A computer educational project produced by a working team at ITECI, based on this emerging Pedagogy of Informatics, has contributed to our knowledge about the use of computers and information technology in education. These materials - embedded in a methodology expressing a pedagogy of informatics - were first tested through intensive courses, and then successfully used for over six years. At present, that program is used at seventeen schools, involving approximately 20,000 students in the cities of Recife, Natal, and Fortaleza, Northeast of Brazil.

Our experience of practical cases and the follow up evaluations of ITECI's methodology and courses at schools settings have shown the importance of basing the uses of computer technologies at schools on a conceptual framework which encompasses multidisciplinary and collaborative approaches in its development and implementation. That led us to be skeptical about use of computers and special software techniques, if they are not connected with an appropriate pedagogy and methodology which guides on how to take advantage of them at the school setting.

As stated above (p.1) computer education in schools has not lived up to the high expectations with which it was introduced. In many cases as the speed with which the technology is developing simply means that teachers and schools get left further behind. This program has been successful in both, the capacitation of teachers and the development of a *Pedagogy of Informatics*. The project assists students to conceptually understand the structure and functioning of computers and software in both historic and contemporary contexts, and enable them to infer, take risks and face new challenges creatively. It is important that educators are given many opportunities to discuss and contribute to the emerging *Pedagogy of Informatics*, and to learn from successful programs such as this one.

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